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Graphene Coatings in Acidic Media (#87)

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Prevention of corrosion of a substrate is relevant in many contexts; it is important when it comes to metals, but also for molecular films as the ones used for instance in organic light-emitting diodes (OLED). Proving that defect-free monolayer graphene is impermeable to all gases including helium has triggered an intense research towards the usage of graphene-based films as barriers [1]. However, the effectiveness of chemical vapor deposited graphene as a protective coating is still subject to debate and controversy since cracks or wrinkles in the graphene film open up windows for localized oxidation, which may progress underneath the graphene itself [2, 3].

In our work, we explore how to improve the intrinsic limitations of graphene-based coatings – *i.e.*, to limit the effect of wrinkles and other imperfections within the graphene film. Using multi-layer graphene is for instance one of the approaches we have been using. Despite the presence of defects, in case of a multi-layered graphene coating, oxygen and water molecules must traverse a complex combination of multiple intercalative paths between the layers, as well as penetrate to deeper layers through lattice imperfections in order to eventually reach the metal surface (see Fig. 1). We have shown in fact that a thick graphene film enhances the lifetime of future-generation bipolar plates based on stainless steel for fuel cells also in very harsh environments [4].

However, we report that the behavior of the barrier coating is much different on nickel in acidic media. The use of 100 nm thick multilayer graphene coatings only results in limited corrosion rate reduction obtained via electrochemical techniques. Moreover, delamination of the coating was seen in acidic media and thus stands in stark contrast to the results in aggressive seawater for the same coating type [4]. Thus even proven multilayer graphene coatings prove ineffective of corrosion protection in acidic media on certain metals.

1. J. S. Bunch et al. Nano Letters 8, (2008) 2458.
2. F. Zhou et al. ACS Nano 7 (2013) 6939
3. M. Shriver et al. ACS Nano 7 (2013) 5763
4. A. C. Stoot et al., Journal of Power Sources 293 (2015)